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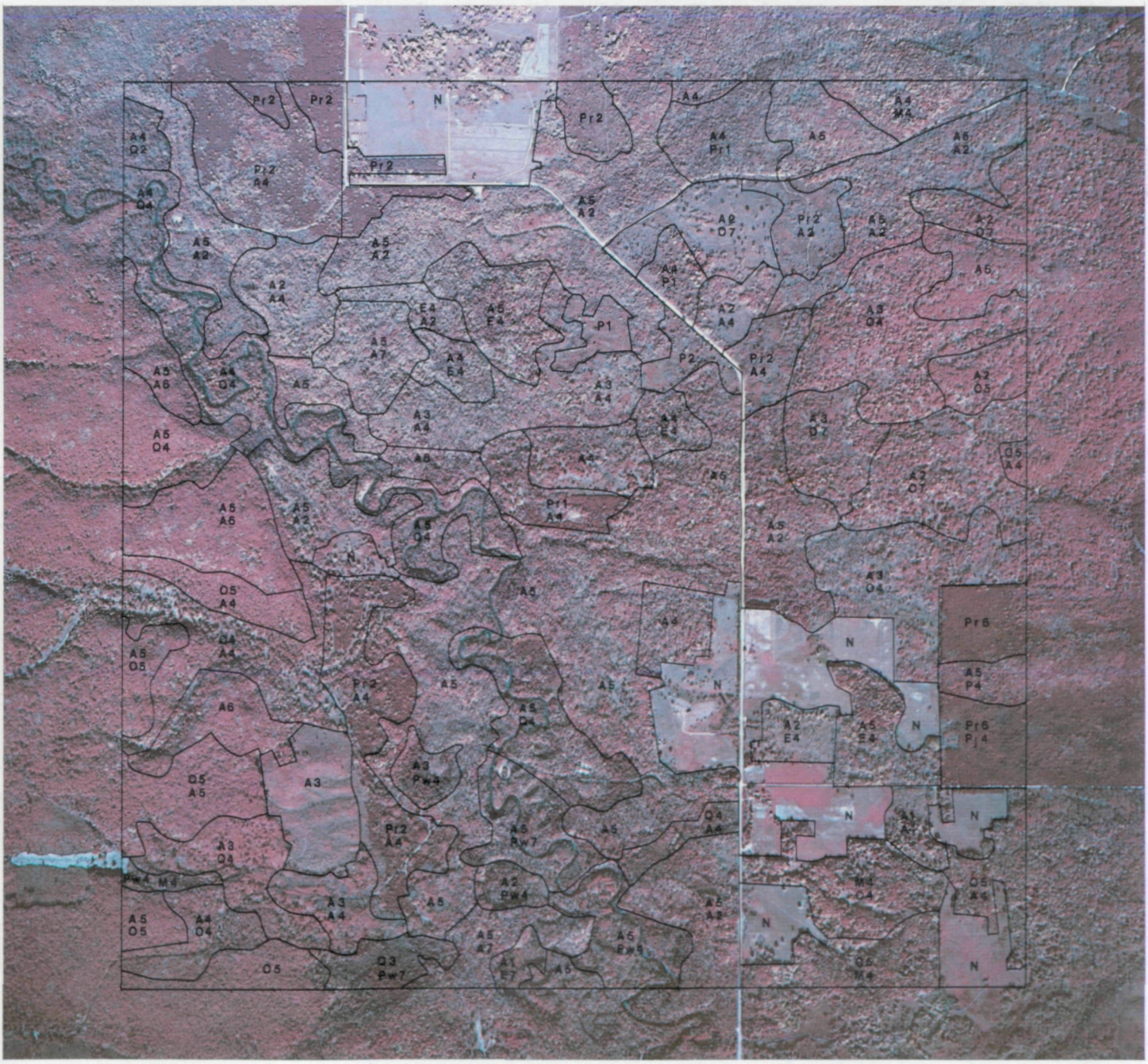
Interpreting Michigan Forest Cover Types From Color Infrared Aerial Photographs



Interpreting Michigan Forest Cover Types From Color Infrared Aerial Photographs

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Introduction

The recognition of forest cover types and individual tree species from aerial photographs often provides needed inventory data with greater accuracy and at lower cost than by ground methods alone. Resource managers (or their staffs) who can extract information from aerial photographs have a powerful tool to aid their information needs.

This publication will provide an introductin to the identification of forest types and tree species from medium scale color infrared aerial photography. The material was originally compiled for use in a short course on the interpretation of color infrared airphotos for forest resource inventories. It was designed to be a practical reference on the techniques of airphoto interpretation and is used to support the lectures and exercises.

While the basic techniques of airphoto interpretation are easily learned, their effective use is normally acquired only by practice. Although considerable training and experience are required before one becomes proficient at delineations, a careful study of the materials in this publication should allow you to begin to make correct interpretations.

Several references exist on species identification that apply to the forests of Michigan. The interpretation of tree species from medium scale (1:15,840 to 1:20,000) panchromatic photography has been covered in Photographic Interpretation of The Species in Ontario (Zsilinszky, 1966). Although it covers tree species in Ontario, most also occur in Michigan. Included are detailed descriptions of identifying features, comparisons of similar species and illustrations of actual photographic stereopairs. Additional work on the forests of Canada, applicable to Michigan forest types, include generalized photo interpretation guides (Sayn-Wittgenstein, 1978) and a series devoted to the recognition of tree species on large scale photos (1:1,000 to 1:3,000) by crown characteristics (Sayn-Wittgenstein, 1960 and 1961).

The use of color aerial photography for identifying certain conifers and hardwoods of the northeastern U.S. has been dealt with by the U.S. Forest Service (Heller, Doverspike and Aldrich, 1964). Interpreting forest types in the Lake States with black-and-white infrared photography (1:12,000 to 1:15,840) is covered in two reports of the U.S. Forest Service (Chase and Korotev, 1947 and Region Nine, U.S. Forest Service, 1947). The latter consists of 49 photographic stereograms illustrating sample forest condition classes and species.

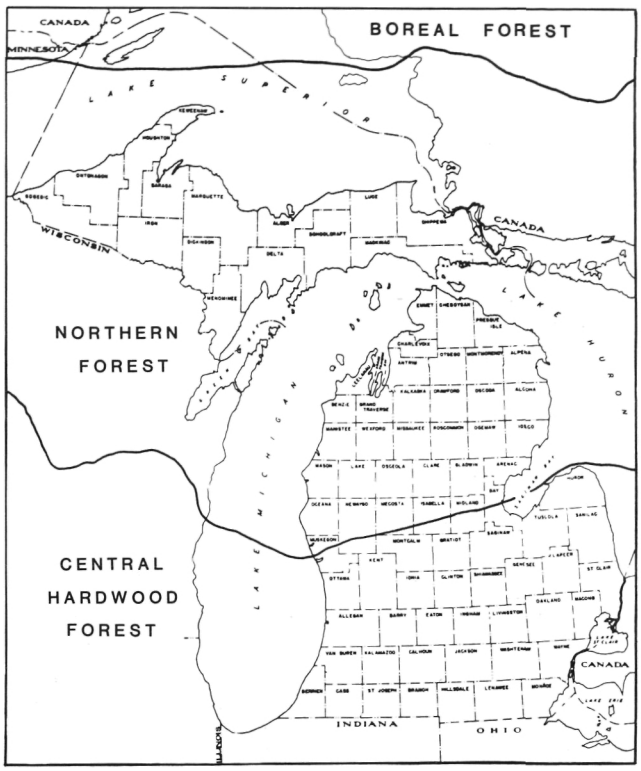

Figure 1. Generalized forest regions in Michigan (individual tree distributions, as compiled by the U.S. Forest Service (Little, 1971 and 1977), are available in the form of tree distribution maps).

The present publication covers interpreting medium scale (1:24,000) color infrared aerial photography for identifying common forest types and tree species of Michigan. This is an extension of a previous effort to develop techniques for mapping forest resources on a county-wide basis (Hudson, Amsterburg and Myers, 1976,).

The characteristics of 17 cover types (13 forest types or tree species and 4 non-forest cover types) and their interpretation are presented. For each type its occurrence is briefly described by forest region (Figure 1) and site requirements are given. Descriptions follow of those attributes of a tree or stand which are helpful when attempting to interpret the type from a vertical perspective. The description of common crown shapes has followed a system (Figure 2) developed by the Canadian

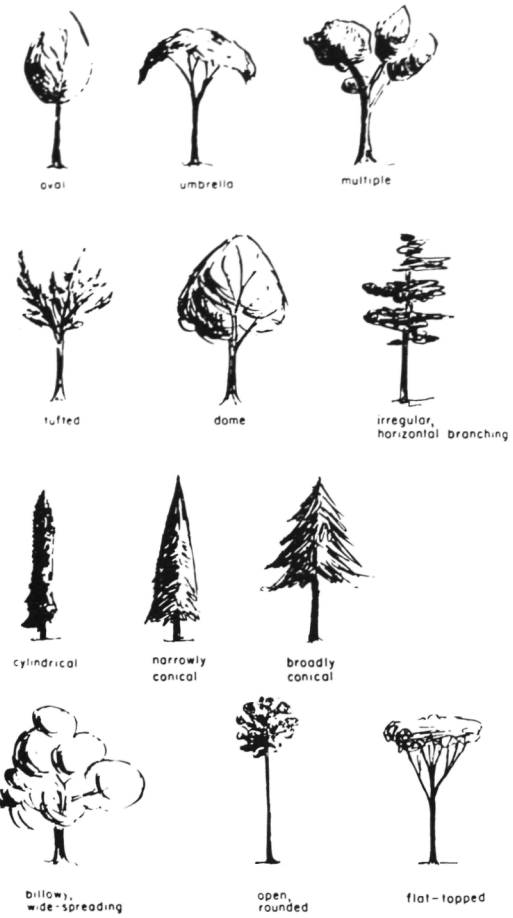

Figure 2. Several common crown shapes (reprinted by permission of the Canadian Forestry Service).

Forestry Service (Sayn-Wittgenstein, 1978). Identification of the forest type or species by using image characteristics (e.g. size, shape, shadow, color, texture, pattern, size or association) is then discussed. Individual types are accompanied by ground photos, sketches and stereograms[1] of "typical" stands.

General knowledge of forest ecology, and thorough knowledge of local environmental conditions, are very important in forest interpretation. With sufficient local experience and data, the interpreter may use phenological phenomena to help distinguish between species and groups. The following events are useful on a given survey: date of leaf flushing, description of immature foliage, date of flowering and fruiting, time of fall coloring, description of fall colors and time of leaf fall (these topics are covered in considerable detail in Sayn-Wittgenstein, 1961b and 1978).

A working knowledge of the ecological and silvicultural characteristics of the species in the area being studied is of great importance in the interpretive process. Knowing site requirements or preferred habitat of species or groupings will often narrow choices or eliminate species. The natural associations of certain species may suggest the presence of a second type, or eliminate the probability of a particular tree species. The tendency of certain species to form characteristic stands (i.e., pure, uneven-aged, coppice stands, etc.) will also be useful in the interpretive process.

[1]Copies of the stereograms, printed on color photographic paper, are available for purchase from the Center for Remote Sensing, 302 Berkey Hall, Michigan State University, East Lansing, MI 48824-1111.

White Pine

White pine[2] occurs throughout the Northern Forest and in portions of the Boreal and Central Hardwood Forest Regions. While more abundant in the Upper Peninsula (U.P.), it is also common in the northern Lower Peninsula. White pine grows on a wide variety of sites in natural stands. More than half of them are located in the western U.P.

White pine occurs as a component of other forest types, either as an overstory or scattered individuals. On moderately well drained, mesic sites, it is associated with sugar maple, yellow birch, beech, basswood and hemlock. On dry sites, such as dunes and outwash plains, it is found with red pine (where it may be a dominant or co-dominant component of the stand), jack pine, red oak, black oak, white birch and quaking aspen. On moist sites,

[2]Scientific names of tree species are given in the Appendix.

Figure 3. White pine illustrating characteristic branching habit.

Figure 4. Mature white pine stand, Allegan State Game Area.

small ridges or mounds in swamps and poorly drained sites, it may occur with white and black spruce, balsam fir, northern white-cedar, quaking aspen and red maple (Barnes and Wagner, 1981.).

In the western U.P., white pine is a frequent component of the northern hardwood, aspen and spruce-fir forest types. In the eastern U.P., it is more commonly found in the cedar, red pine and black spruce forest types. In the northern lower Peninsula, it is a common component of the oak and aspen forest types. White pine is a commonly planted species, though not as common as red or jack pine.

White pine is one of the tallest trees in Michigan and usually has a straight, undivided trunk. Branches along the stem are often large and occur at nearly right angles in a whorl-like arrangement. Those in the upper crown are smaller and sweep upwards (Figures 3 and 4).

When viewed from above, the large horizontal branches are very prominent, giving the crown an irregular star-shaped outline (figures 5 and 6). This distinctive shape is clearly displayed on trees which are over-mature, open-grown, or in mature stands where white pine towers above associated species (area 3 in Figure 58). Young white pines often have nearly conical or pyramidal shaped crowns.

Identification is possible by recognition of a shelf-like pattern displayed by shadows. Color varies from light purple to salmon but is always the "lightest" of the three pines (Figure 7.). Plantation white pine may be distinguished by its color, light brown to salmon, and its "ragged" or "fuzzy" texture, especially as compared to red or jack pine plantations (area 1 in Figure 58).

Figure 5. Schematic diagram of white pine illustrating vertical and horizontal views (Figures 5, 9, 14, 19, 24, 28, 32 and 36 reprinted by permission of the Canadian Forestry Service, from Sayn-Wittgenstein, 1960).

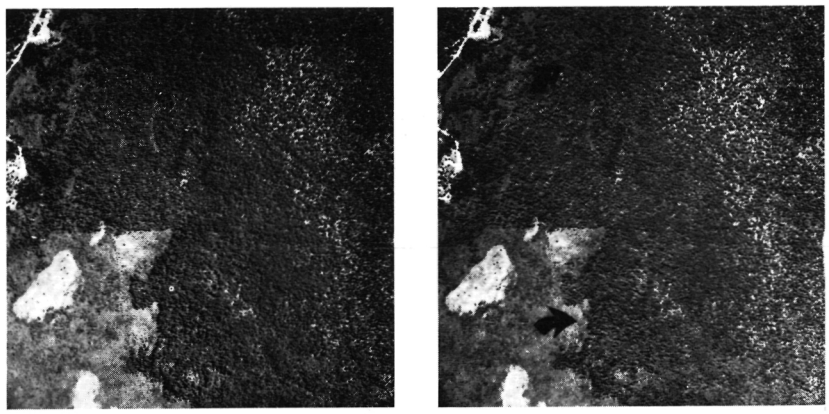

Figure 6. White pine stand, Kalkaska County.

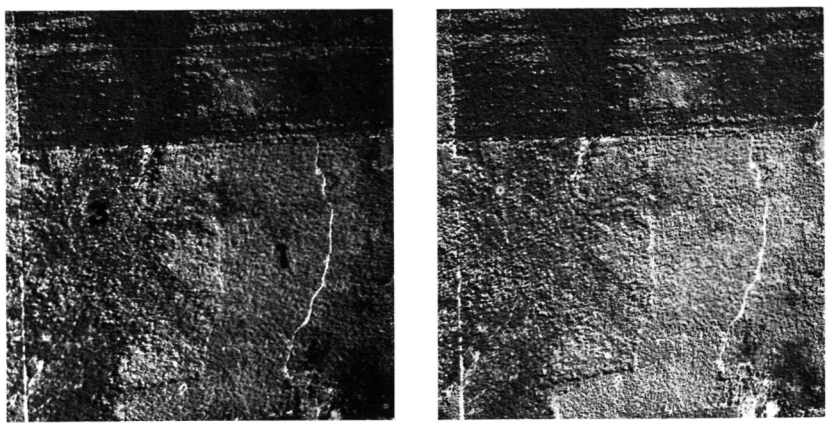

Figure 7. White (1), red (2), and jack pine (3) plantations illustrating relative tonal differences.

Red Pine

Red pine is primarily a tree of the southern Lake States, but does occur farther north with a scattered distribution. It is commonly found on level or gently rolling sand plains throughout the northern Lower Peninsula and portions of the U.P.

Red Pine grows in both pure and mixed stands. Commonly associated species include jack pine, aspen, white birch and northern pin oak on dry sites and white pine, red maple, red oak, balsam fir and white spruce on moist sites. Red pine is a frequent component of the aspen, white pine and jack pine forest types in the western U.P.; the jack pine cover type in the eastern U.P.; and the aspen-paper birch and oak forest types in the northern Lower Peninsula. Red pine is the most extensively planted species in Michigan.

Red pine has a straight, columnar trunk often clear of branches for one-half to two-thirds of its height. Large, horizontal and spreading branches form a broadly-rounded crown which is rather open (Figure 8).

As viewed from above, the crown appears circular, beyond which individual branches rarely protrude (Figures 9 and 10). Red pine may be distinguished by a honeycombed stand pattern and a saw-toothed profile (Zsilinszky, 1966) (Figures 11, 12 and 13). Color will be a reddish-brown or sometimes a light-true-brown, intermediate between white and jack pine. Red pine stands appear more uniform and less "jagged" than stands of white or jack pine (Figures 7, 13 and 58).

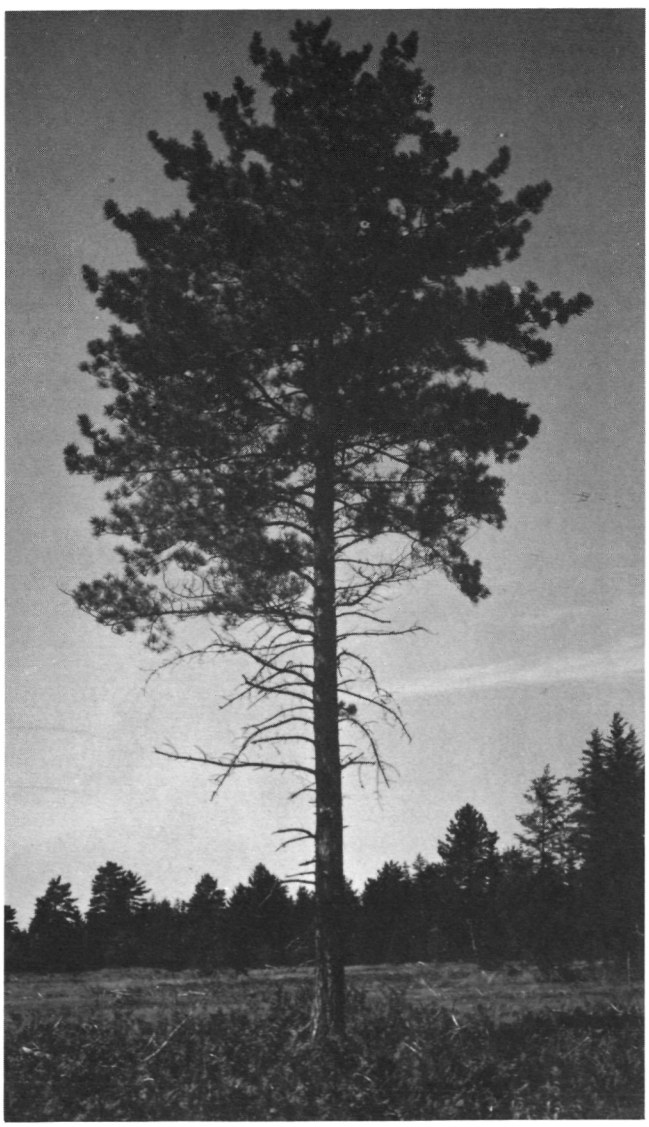

Figure 8. Red pine illustrating straight, undivided trunk and broadly-rounded crown.

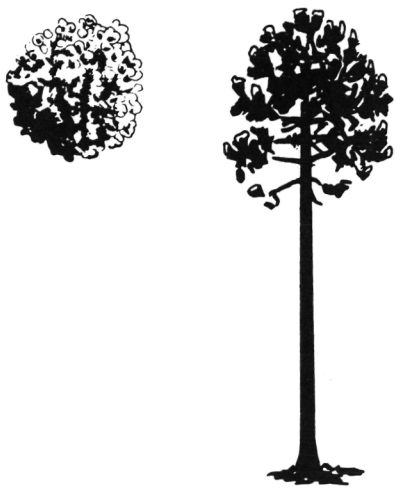

Figure 9. Schematic diagram of red pine illustrating vertical and horizontal views.

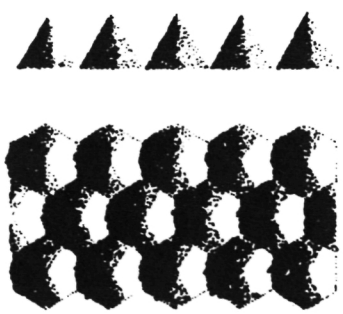

Figure 11. Schematic diagram of the saw-toothed stand profile and honeycomb stand pattern of red pine (reprinted from Zsilinszky, 1966).

Figure 12. Red pine plantation illustrating saw-toothed profile.

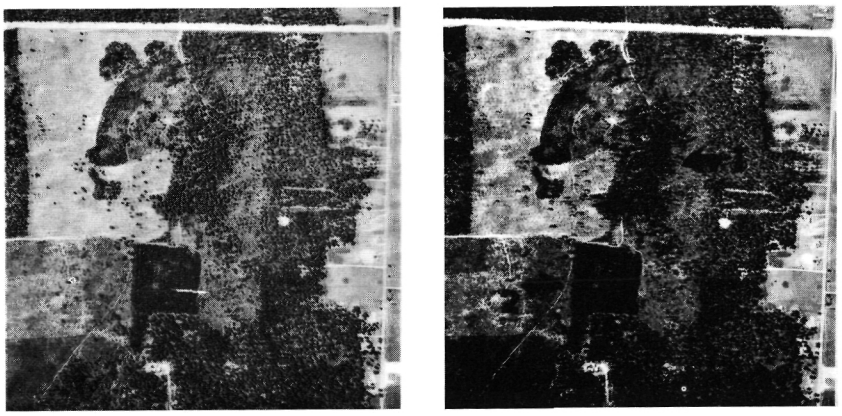

Figure 10. Red pine stands, Montmorency County; 1) natural stand, 2) plantation.

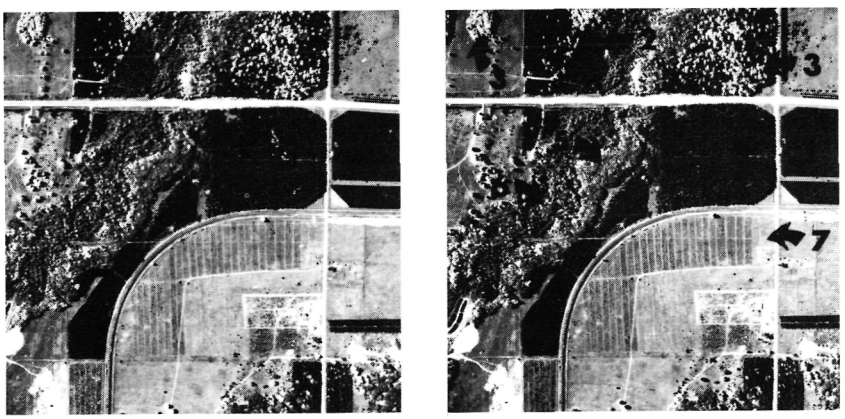

Figure 13. Forest cover types: 1) red pine plantation, 2) northern white-cedar, 3) northern hardwoods, 4) jack pine plantation, 5) aspen, 6) lowland hardwoods and swamp conifers and 7) Christmas tree plantation.

Jack Pine

Jack pine occurs extensively in Michigan, common in both the Boreal and Northern Forest Regions. This species is found on a variety of sites, but is most characteristic of dry, coarse, sandy outwash plains. It occupies large areas of these plains in both the U.P. and central portions of the northern Lower Peninsula.

Common, associated species include: red pine, northern pin oak, black oak and bigtooth aspen. Jack pine is often a component of the oak, aspen and red pine forest types. Farther north, jack pine may occur on more moist, sandy soils near swamps where it may be associated with black spruce and tamarack. Jack pine is a commonly planted species.

Jack pine normally forms a small, narrow crown of short branches with a roughly cylindrical shape (Figures 14 and 15). This is especially true of trees growing in closed stands. When open grown, the crowns tend to be rounded but irregular. When viewed from above, jack pine crowns appear irregularly rounded, fuzzy and relatively small and pointed (Figures 16, 17 and 18).

Pure jack pine stands appear hazy with a somewhat uniform texture, which contrasts with the more ragged appearance of spruce. Jack pine normally appears as a blue-black color, but may tend towards black or blackish-brown. It always has the darkest tone of the three pines (Figure 7). Plantations appear more irregular than red pine, but often more uniform than white pine (Figures 7 and 13).

Figure 14. Schematic diagram of jack pine illustrating a relatively small, pointed crown.

Figure 15. Jack pine stand illustrating typical crown shapes.

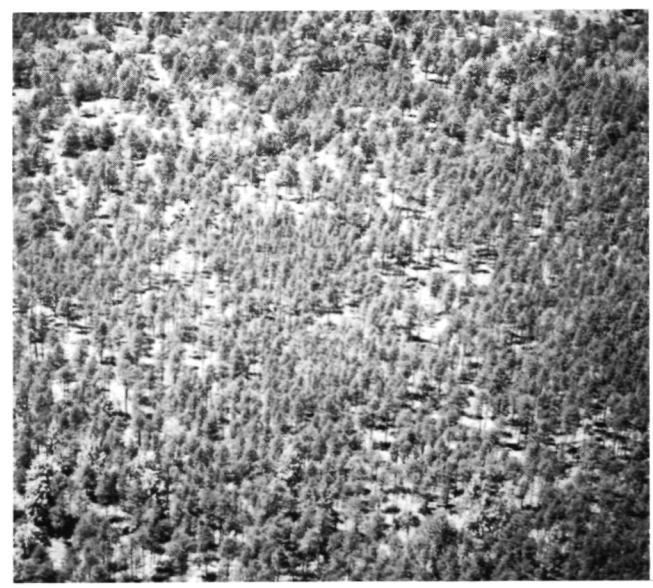

Figure 16. Oblique view of jack pine illustrating fuzzy appearance.

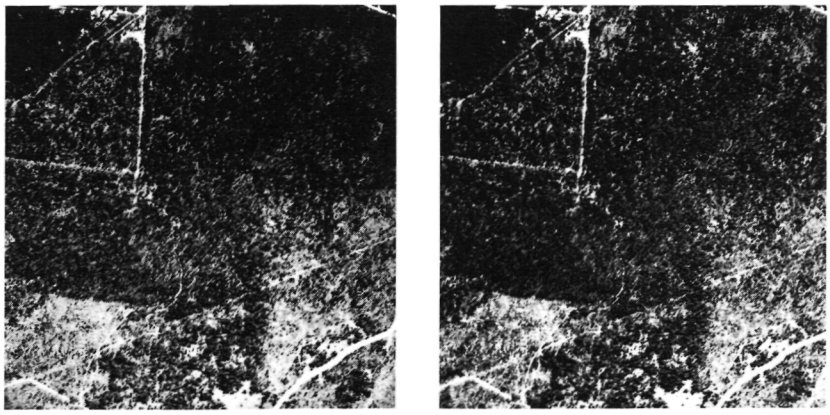

Figure 17. Jack pine stand, Kalkaska County.

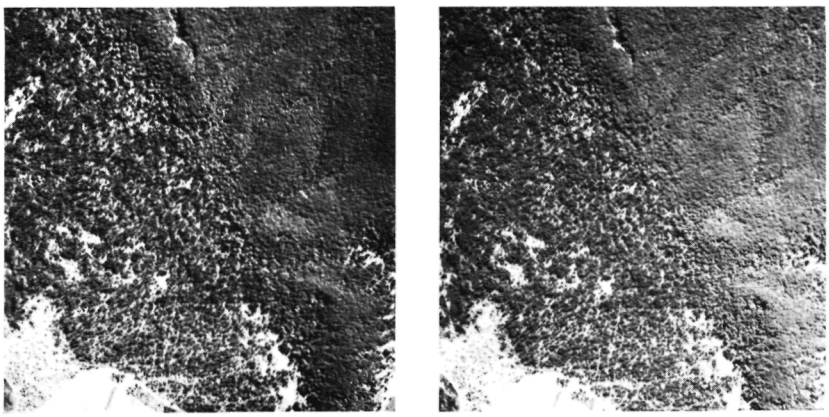

Figure 18. Jack pine stand, Crawford County.

Tamarack

Tamarack is widespread throughout the Boreal and Northern Forest Regions. It reaches the southern limit of its range in the northern portions of the Central Forest Region. It is usually confined there to small, relic stands in bogs and swamps.

In the northern part of its range, the northern Lower Peninsula and especially the eastern U.P., tamarack is a characteristic tree of wetland sites where it is either a pure type or in association with black spruce. On the more productive swamp sites, it may form part of the mixed conifer swamp type, a mixture of northern white-cedar, black spruce, balsam fir and tamarack - - none of which comprises a majority of the stand (Eyre, 1980). On upland sites, associated species include: balsam fir, white birch and aspen.

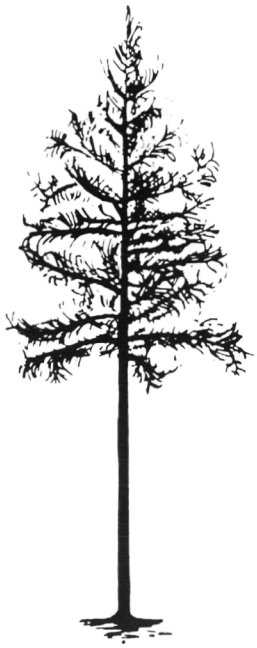

Figure 19. Schematic diagram of tamarack illustrating the characteristic open, pyramidal shape.

Being exceedingly intolerant of shade, tamarack frequently grows in the open or, if growing under forest conditions, it is usually dominant with its crown above the level of the crown canopy.

Tamarack is a medium-sized tree with a straight, undivided trunk. The crown consists of short horizontal branches forming an open, pyramidal shape (Figures 19 and 20).

Tamarack may be identified by its symmetrical, cone-shaped crown and light purplish-blue color (Figures 21 and 67). It is distinguished from black spruce, its common associate, by the somewhat broader crown and lighter color.

Figure 20. Tamarack illustrating typical crown shapes.

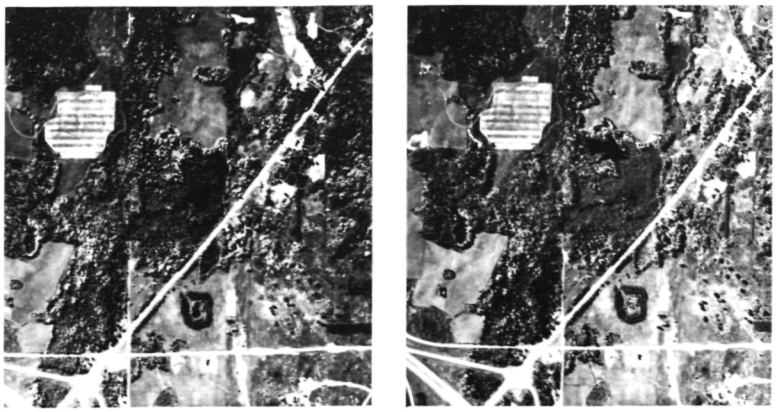

Figure 21. Tamarack, Wexford County.

Spruce-Fir

The spruce-fir forest type, although usually found in the Boreal Forest, occurs in both the Upper Peninsula and the northern Lower Peninsula. Balsam fir is typically the most abundant species of this cover type. White spruce, along with quaking aspen and white birch, are the most frequently occurring associated species.

The type is usually represented by pure stands of balsam fir, and less frequently white spruce, although it occupies a relatively small areal extent. Both species are components of the northern hardwood and aspen forest types in the Upper Peninsula and the cedar and aspen forest types in the northern Lower Peninsula. Balsam fir often occurs as an understory in the aspen and paper birch types. Although found on a variety of sites, this type is typical of mesic to moist conditions.

White spruce is a medium to large tree with a single, straight trunk. The crown is often large, dense and conical. The symmetrical crown forms more of a broader cone than black spruce or balsam fir (Figures 22, 23 and 24).

When viewed from above, spruce-fir stands may be identified by thier symmetrical, broadly conical and pointed crowns (Figures 24, 25 and 26). The type may display an irregular stand profile with a rough, uneven texture. Color will vary, depending on the site, from light brown to a deep purplish magenta (Figures 26 and 27).

Figure 22. White spruce illustrating broadly conical crowns.

Figure 24. Schematic diagram of white spruce (left) and balsam fir (right) illustrating vertical and horizontal views.

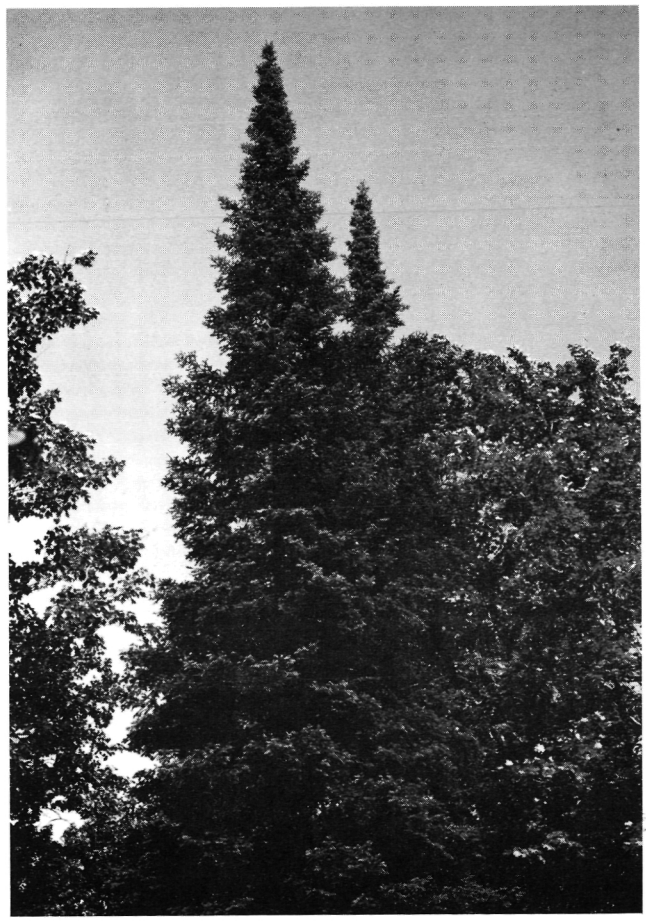

Figure 23. Balsam fir illustrating a slender, very symmetrical, cone-shaped crown.

Figure 25. Oblique view of the symmetrical, cone-shaped crowns of balsam fir.

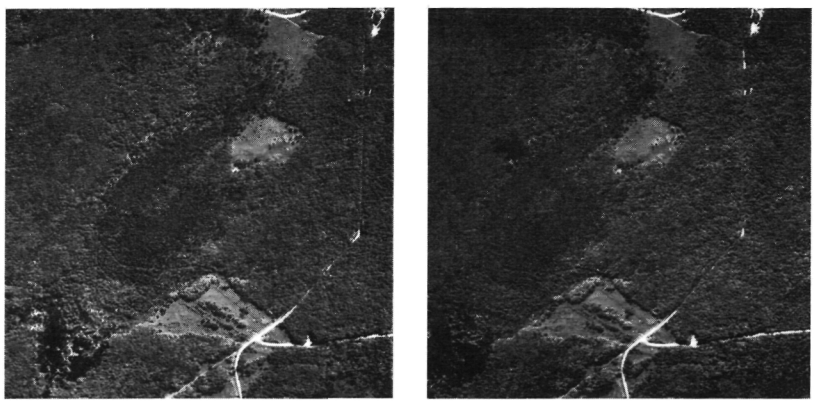

Figure 26. Spruce-fir forest type, Alger County; the surrounding forest type is northern hardwoods.

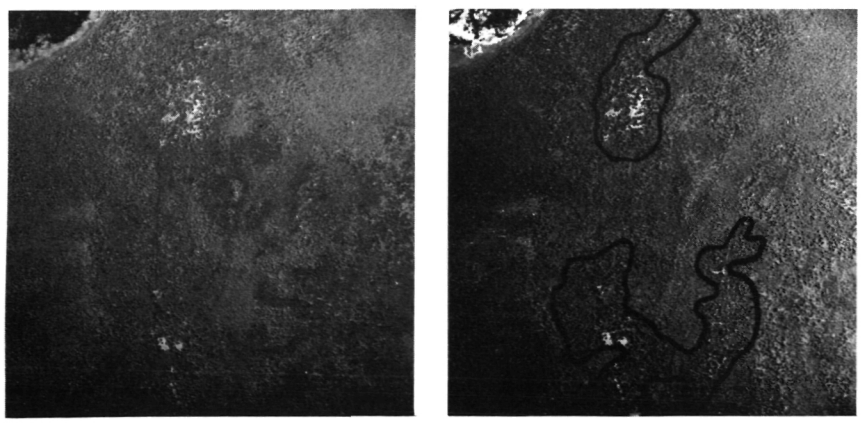

Figure 27. Spruce-fir forest type, Mackinac County.

Black Spruce

The black spruce forest type is fairly widespread and common in the northern part of its range, but is much less common in the southern parts of Michigan, being quite rare in the southern Lower Peninsula. The type grows on organic soils, sphagnum bogs and poorly drained swamps.

Black spruce often occurs in pure stands but may contain white pine, cedar and balsam fir as associated species. Black spruce is also found in the cedar, spruce-fir and aspen forest types in the Upper Peninsula. It may occur as a pure type in the northern Lower Peninsula, being most commonly found in cedar, spruce-fir and mixed conifer swamps.

Black spruce is a relatively small tree, seldom exceeding a height of 60 feet. It has a slender trunk with little taper, supporting a narrow, irregularly conical to nearly cylindrical crown (Figures 28 and 29).

Black spruce is recognized by its slender and almost cylindrical crown which appears fairly smooth (Figure 30). Stands appear quite regular, especially pure stands, with even or gradual changes in height. Color varies from light to dark but is always a bluish-black hue (Figures 43 and 52).

Figure 28. Schematic diagram of black spruce illustrating the narrow, nearly cylindrical crown.

Figure 29. Black spruce illustrating characteristic crown shapes.

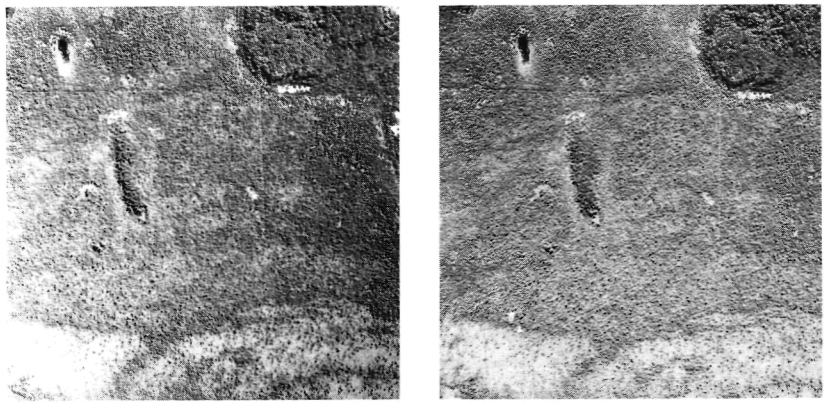

Figure 30. Black spruce stand, Delta County; the broadleaved trees on the higher sites are northern hardwoods.

Hemlock

Eastern hemlock occurs throughout the Northern Forest, but is most common in the western U.P. It occurs to some extent in the northern Lower Peninsula, but is restricted in the southern Lower Peninsula to cool, moist sites. It may form pure stands but is usually found in groups within the northern hardwood forest type. The type prefers moist flats and low-lying areas but is also found on drier sites. Commonly associated species include: beech, sugar maple, red maple and yellow birch.

Eastern hemlock is a large tree with a straight trunk supporting a broadly conical crown (Figure 31). The crown is broader than those of balsam fir and white spruce and has a less apparent taper (Figure 32). When viewed from above, hemlock crowns will appear irregularly rounded and somewhat star-shaped, although not as prominant as white pine (Figures 33 and 34). The type displays a rough texture and appears a deep purple magenta.

Figure 31. Hemlock illustrating the characteristic broadly conical crown.

Figure 32. Schematic diagram of hemlock illustrating a broad crown with little taper.

Figure 33. Schematic diagram comparing the crown shapes of white pine (Pw) and hemlock (He), reprinted from Zsilinszky, 1966.

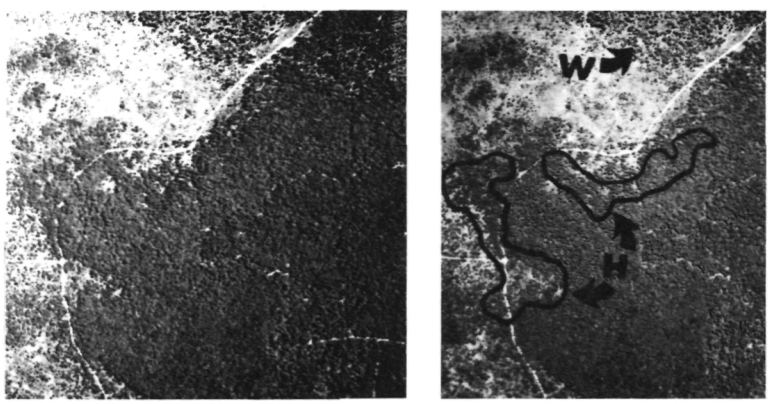

Figure 34. Hemlock (H) and white pine (W) stands, Luce County; the surrounding broadleaved forest is predominantly northern hardwoods.

Northern White-Cedar

Northern white-cedar occurs in the Boreal Forest, but is more common throughout the Northern Forest. It is most common in the eastern U.P. and the northern Lower Peninsula, but does occur in the western U.P. and even into the southern Lower Peninsula. The cedar type is primarily found on organic soils of swamps and along stream borders, but not in stagnant swamps or bogs. It also occurs on limestone uplands, especially adjacent to the Great Lakes.

Northern white-cedar grows in both pure stands and as a component of the mixed conifer swamp type. Commonly associated species include: balsam fir, black spruce, white pine, tamarack, black ash and red maple. Cedar may also form a component of the spruce-fir and lowland hardwood forest types.

Northern white-cedar is normally a small tree which seldom exceeds 50 feet in height. The tapering trunk normally supports a full dense crown, slightly conical, and has a rounded top (Figures 35 and 36). When growing in dense stands, as in a swamp, the individual trees display a variety of shapes and appear more "pointed" than open grown trees (Figure 37).

The cedar type is recognized by the dense, very smooth crown, though not as symmetrical as balsam fir. Stands may appear open with an irregular stand pattern (Figure 38). Cedar is normally a distinctive dark brown-magenta (Figures 58 and 13).

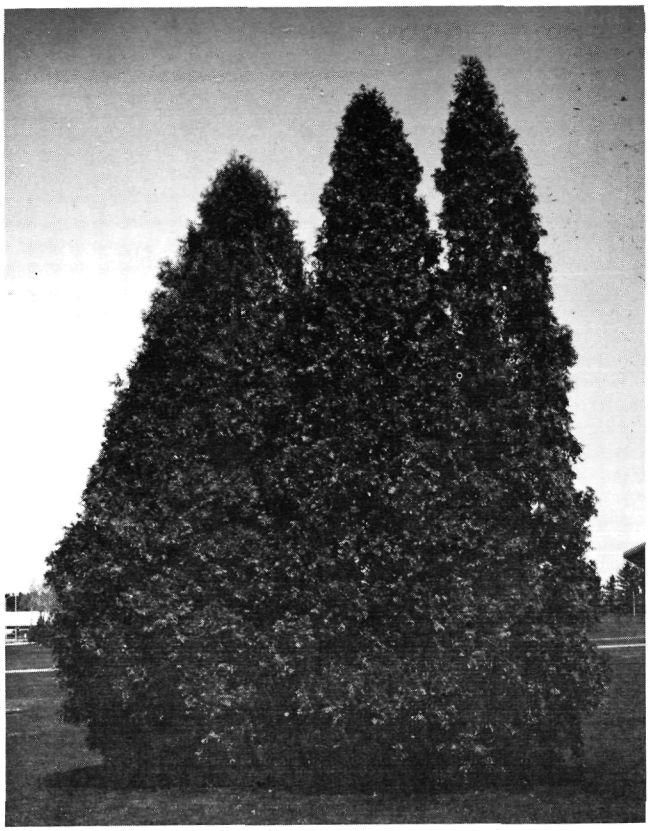

Figure 35. Northern white-cedar illustrating characteristic crown shapes.

Figure 37. Dense stand of northern white-cedar with "pointed" crown tips.

Figure 36. Schematic diagram of northern white-cedar illustrating vertical and horizontal views.

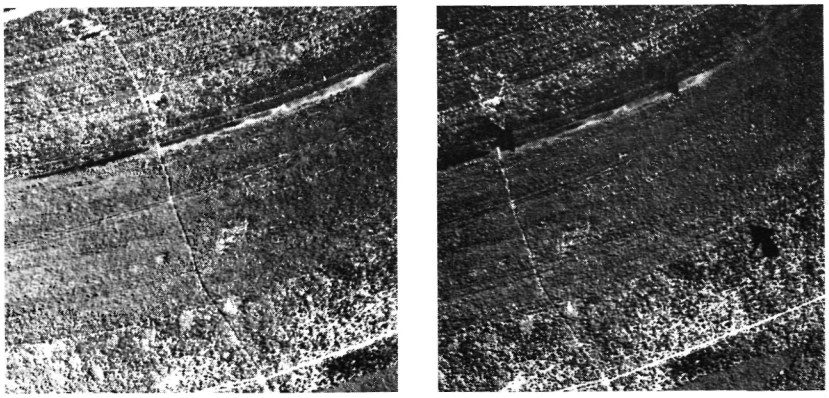

Figure 38. Northern white-cedar, Presque Isle County.

Aspen

The aspen type is very widespread throughout the Northern and Boreal Forests, and is commonly found in the Central Forest. Aspen is very common throughout Michigan, although the largest acreage is found in the northern Lower Peninsula. It is found on most sites except the driest sands and wettest swamps. Trembling or quaking aspen is found on a variety of soils. Bigtooth aspen is restricted to more mesic or dry sites.

Figure 39. Aspen illustrating the characteristic straight trunk and small, somewhat rounded crown.

The most common species found in association with aspen are paper birch, red maple and pin cherry, with balsam poplar often present on wetter sites. Quaking aspen is sometimes a component of the northern hardwoods, spruce-fir and lowland hardwood forest types while bigtooth aspen is commonly associated with both the northern hardwood and oak (especially in the northern Lower Peninsula) forest types.

Both of the aspens have single, straight trunks, with branching mainly confined to the upper reaches of the tree (Figure 39). Since they are intolerant species and occur in even aged stands, aspen displays a uniform stand pattern. Crowns are rounded, small (as compared to the tree's height) and consist of relatively few branches (Figures 40, 41, 42, 43 and 52.). Because of its thin foliage, aspens cast lighter shadows than most other hardwoods.

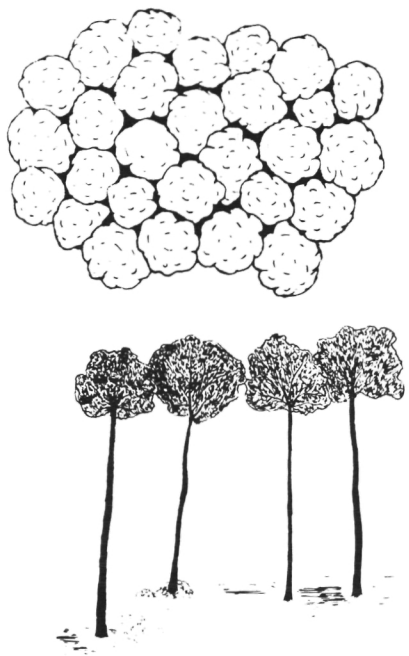

Figure 40. Schematic diagram of an aspen stand illustrating horizontal and vertical views.

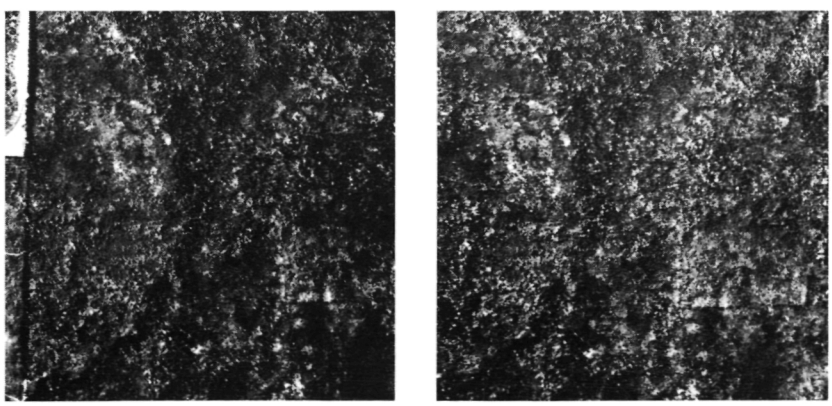

Figure 41. Aspen stand, Wexford County.

The stand structure is very systematic and a high density of stocking (many thousands of trees per acre) produces an unbroken, grainy texture (Figures 43 and 44). The tendency to form clones can result in a stand pattern which appears patchy or "clumpy" with single clones typically 1/10 to an acre in size. The aspen type normally appears a bright red or magenta; fall coloration produces pink and, eventually, white colors. Coloration may be patchy whenever clonal grouping is present.

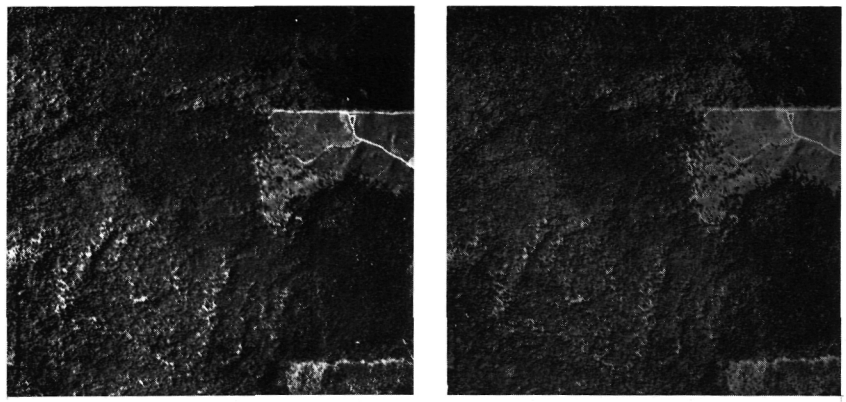

Figure 42. Aspen stand, Montmorency County.

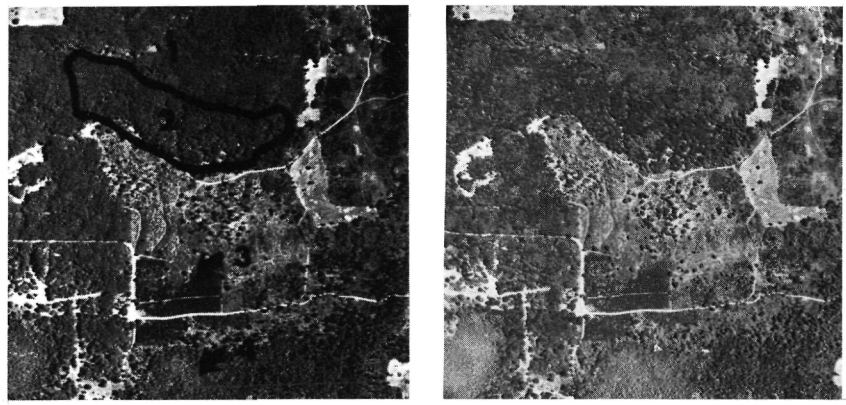

Figure 43. Forest cover types: 1) aspen, 2) oak, 3) red pine plantation and 4) black spruce; the cleared area, between 2 and 3, supports reasonably thick aspen reproduction.

Figure 44. Dense stand of aspen reproduction.

White Birch

White birch is found throughout the Boreal and Northern Forest Regions. In Michigan, it is most common in the northern half, reaching its southernmost limit in the southern Lower Peninsula. White birch grows on a variety of upland sites, and along lake and stream borders and as a pioneer on burned and clear-cut areas.

The type may occur as a pure stand or with the following associated species: quaking aspen, red maple, white pine and balsam fir. White birch is also a component of the northern hardwood, aspen, cedar and lowland hardwood forest types.

White birch has two distinct growth forms: single, straight stems (Figure 45) and multiple, often leaning clumps (Figure 46). Crowns may be ovoid to irregularly rounded and are usually smaller than those of aspen.

When occuring in pure groups or stands, the stand pattern is quite regular and even (Figure 47) or displays a "patchy" pattern due to coppice clumps. White birch appears bright red magenta or occasionally a reddish-pink.

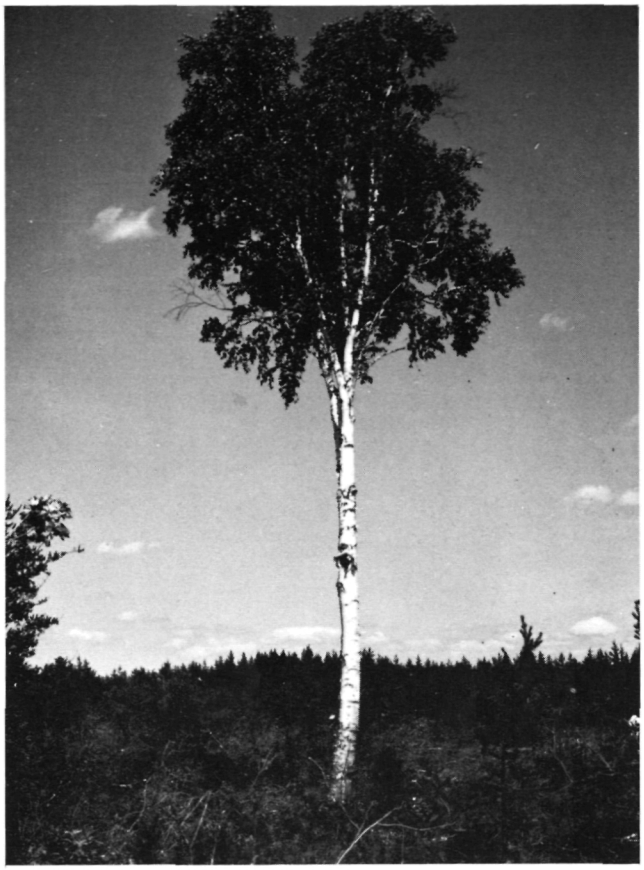

Figure 45. White birch illustrating a single, straight trunk.

Figure 46. White birch illustrating multiple, leaning clump form.

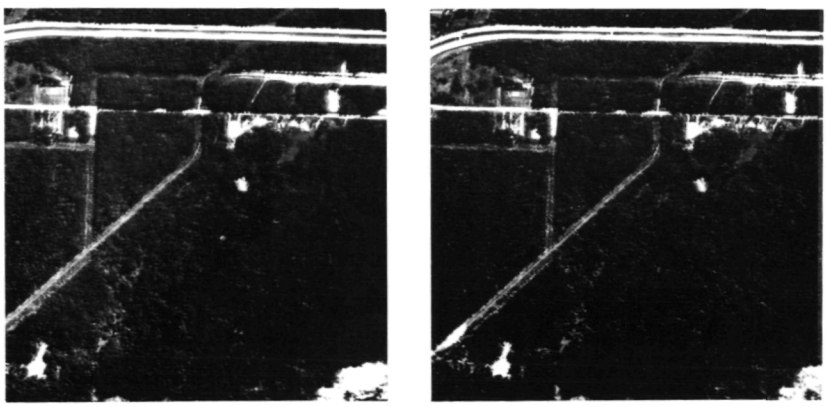

Figure 47. White birch stand, Emmet County.

Oak

The oak forest type is widespread in the Central Forest Region and the southern portion of the Northern Forest Region. Since most oaks reach the northern limit of their ranges in Michigan, the oak forest type is most abundant in southern Michigan. Oaks occur on a variety of sites, but are commonly found on mesic to dry upland soils. The composition widely varies, changing from the oak-hickory associations of the Central Forest in the southern Lower Peninsula, to a northern mixed oak complex, often referred to as "scrub oak," on the outwash plains of the northern Lower Peninsula (Arend and Scholz, 1969).

Principal species include northern red oak, white oak, black oak and shagbark hickory in the south with black oak, northern red oak, white oak and northern pin oak more abundant in the northern Lower Peninsula. Northern and central hardwoods are commonly associated species on the better sites, whereas red maple, aspen and jack pine are associates on the more droughty sites. The oak species also occur as components of both the northern hardwood and aspen forest cover types.

Most oaks are medium to large trees with straight trunks supporting a few large, spreading branches. The crowns are large to massive and relatively broad when compared to the trees' height (Figure 48). The larger branches are somewhat ascending, and the overall crown solid and somewhat round-topped (Figure 49).

Figure 48. White and Black oaks illustrating broad, spreading crowns.

Figure 49. Black oak illustrating ascending branches and round-topped crown.

Oak stands are recognized by their broad, solid crowns, even stand pattern and rounded or wavy texture (Figures 43, 50, 51 and 52). Occasionally a stand will display a rough, somewhat broken texture due to scattered, small openings in the stand. Oaks appear from light to deep red or magenta except during fall coloration when they appear a rusty-red brown (sometimes orangish-brown-red).

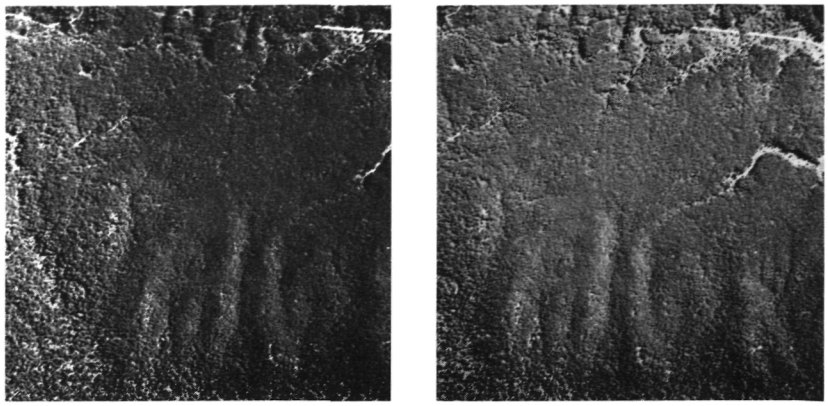

Figure 50. Oak stand, Crawford County.

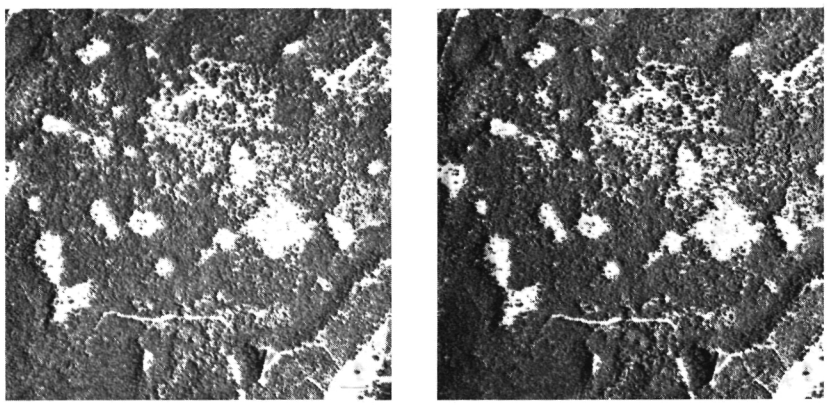

Figure 51. Oak forest cover type, Muskegon County.

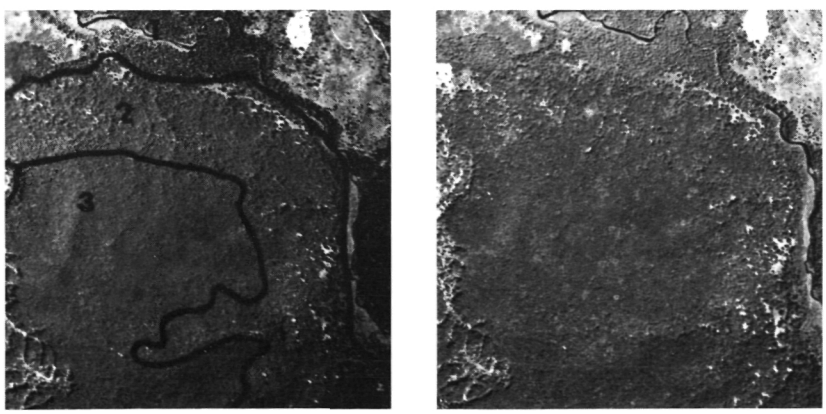

Figure 52. Forest cover types: 1) black spruce, 2) oak and 3) aspen.

Northern Hardwoods

Northern hardwoods is a broadly defined forest cover type used to describe several upland association. The major northern hardwood species is sugar maple in various mixtures including yellow birch, basswood, eastern hemlock and red maple. Sugar maple is dominant in most stands and is the most characteristic species. Other, associated species include: white ash, black cherry, red oak, white spruce, white pine and balsam fir.

The type is generally found on loamy soils with good fertility and moisture conditions, but may extend into sandy soils. The type covers extensive areas throughout Michigan, especially in the western U.P. Old-growth stands are typically uneven-aged, whereas many second growth stands are even-aged.

Because of the number of species and their associations, it is difficult to describe a typical stand. Most of the species are relatively shade tolerant and support a medium to large, irregularly rounded crown (Figure 53). Stand structure, especially in young, even-aged stands, appears solid and even (Figures 54 and 55). Although the crowns may be small and about the same size, they are irregular in outline when compared to aspen or white birch (Figure 56). Crown texture is a distinctive feature, especially when the stand is composed of a variety of species and/or tree and crown sizes, and appears rough with distinctive crown-edge shadowing (Figures 26, 57 and 58). The northern hardwood type displays variable colors within a stand, the colors ranging from shades of pink to dark red and creating a mottled effect (maples produce a distinctive pink color [Figure 30]).

Figure 53. Yellow birch illustrating a large, irregularly rounded crown.

Figure 54. Profile view of a northern hardwood stand illustrating the solid and even stand structure.

Figure 55. Schematic diagram of a northern hardwood stand illustrating horizontal (left) and vertical (right) views.

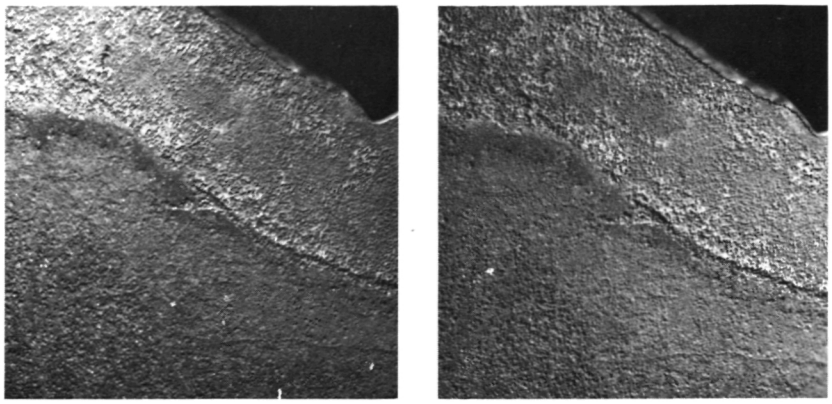

Figure 56. Northern hardwood stand, Alger County. Note the small but irregular crown shape.

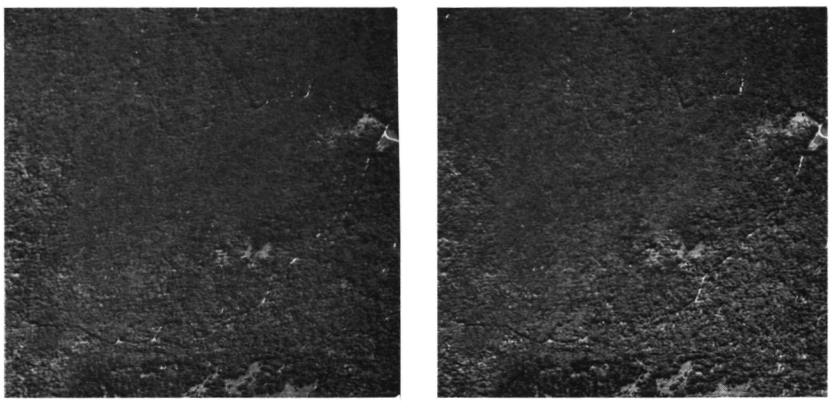

Figure 57. Northern hardwood stand, Alger County.

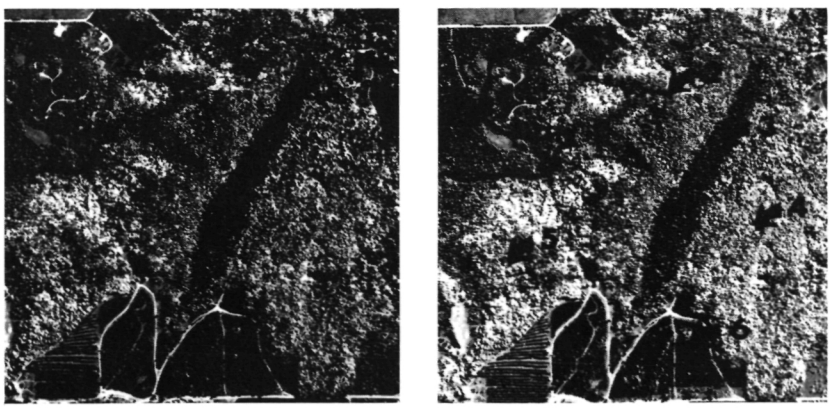

Figure 58. Forest cover types: 1) white pine plantation, 2) aspen, 3) scattered white pine over northern white-cedar, 4) northern hardwoods, 5) lowland hardwoods and 6) red pine plantations.

Lowland Hardwoods

Lowland, or swamp, hardwoods occur throughout the Northern Forest and into parts of the Central Forest. Occupying moist to wet mineral and muck or shallow peat soils, they are found in swamps, gullies and small depressions of slow drainage or in elongated areas along small sluggish streams, occasionally covering extensive areas. This type often grades into northern white-cedar on the wetter sites.

Principal species include black ash, elm, red maple and, in the northern Lower Peninsula, balsam fir. Common, associated species are: basswood, eastern hemlock, white birch, white pine, aspen, northern white-cedar, tamarack and black spruce. While the type is commonly found in the northern Lower Peninsula and the eastern U.P., it can be found in the southern Lower Peninsula or the western U.P. where site conditions are favorable.

The lowland hardwood species may be recognized by their large, ascending branches spreading from the trunk (Figure 59). When viewed from above, these branches display a characteristic forked or divided crown and produce a rough texture (Figure 60). The type is separated from aspen by its more broken and staggered stand pattern and from swamp conifers by the large, ascending branches and rounded crowns of the hardwoods (Figures 58 and 61).

The ground often appears as very dark colors beneath this type due to the open nature of the stands, soil moisture and under-story vegetation (Figures 60 and 62). Lowland hardwoods display a rough, uneven texture and vary in color from dark pink to purple (Figures 13 and 58). Because of their topographic location, lowland hardwoods are some of the first trees to show fall coloration (Figure 63). Bright shades of yellow, pink and greens are common of this type.

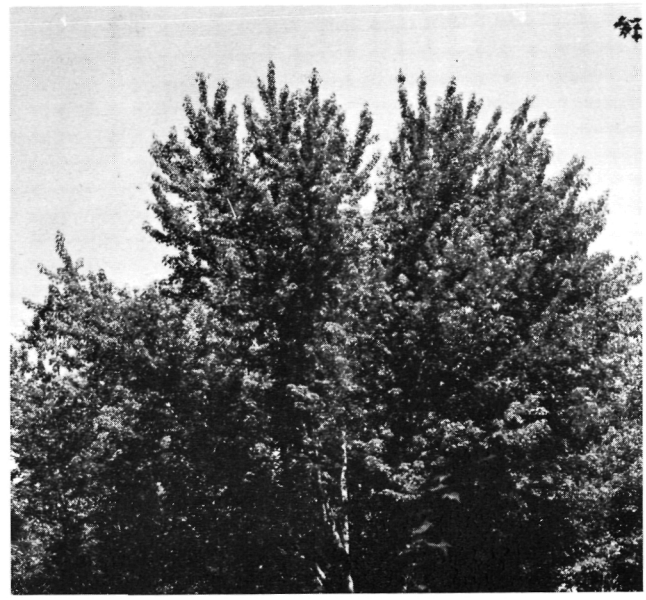

Figure 59. Red maple illustrating ascending branches, characteristic of many lowland hardwood species.

Figure 60. Schematic diagram of a lowland hardwood stand illustrating horizontal (left) and vertical (right) views.

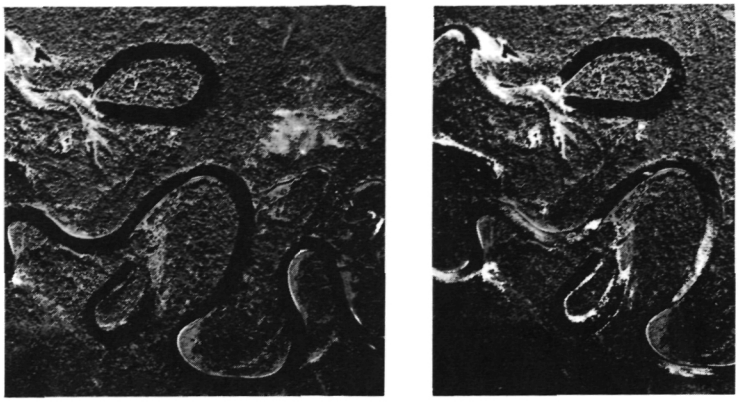

Figure 61. Lowand hardwood stand, Schoolcraft County.

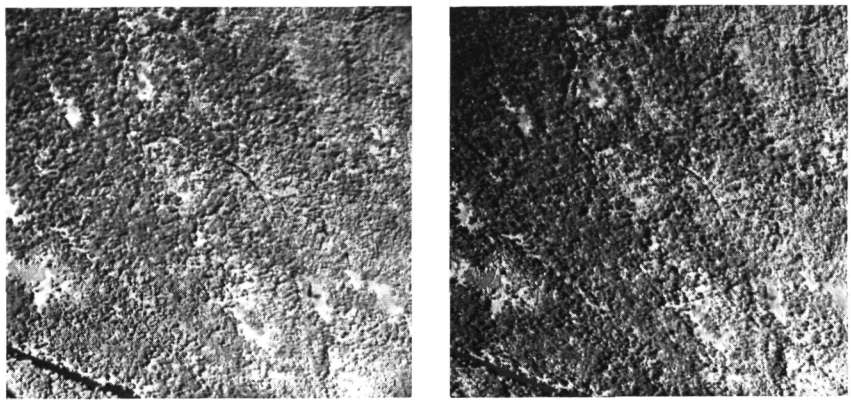

Figure 62. Lowland hardwood stand, Muskegon County.

Figure 63. Oblique view of lowland hardwoods showing fall coloration while the upland forest types are still predominantly green.

Nonforested Cover Types

Lowland Brush

Lowland brush (alder, dogwood, willow, etc.) often forms clumps of several crooked stems (Figure 64) which merge to form a continuous canopy. The crowns are indistinct and create a somewhat rough (wavy) texture (Figure 65). The canopy may be solid or broken by patches of open water, aquatic plants or scattered trees.

Lowland brush is distinguished from aspen reproduction by its topographic location, irregular stand pattern and lack of evidence of logging or other disturbance. This type normally appears in shades of "rusty-red" magenta.

Figure 64. Lowland brush illustrating characteristic stand profile.

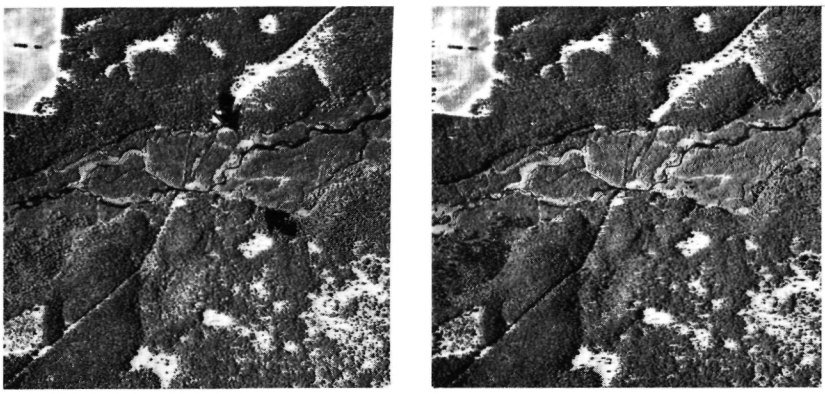

Figure 65. Lowland brush, Muskegon County.

Bog/Treed Bog

These areas of peat land or muskegs support mosses and low bog shrubs and occasionally a sparse stocking of tamarack, spruce, cedar, aspen or jack pine (Figure 66). Bogs follow the contour of a topographic low or depression and may contain open water in the middle. This type has a rusty-orange or rusty-light-brown color and presents a smooth to grainy texture (Figure 67).

Figure 66. Bog supporting low bog shrubs and scattered tamarack and black spruce.

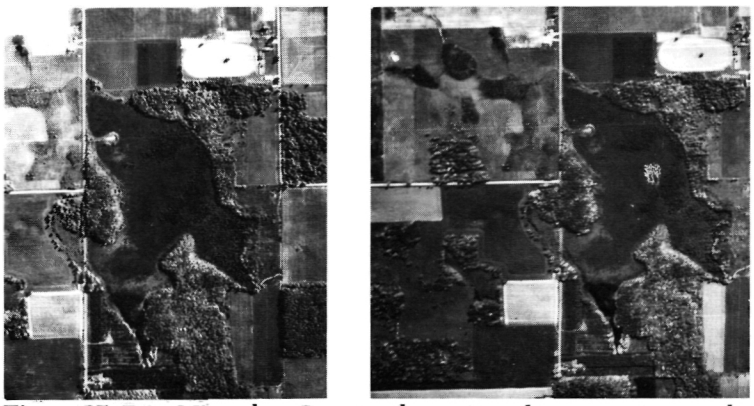

Figure 67. Bog, Missaukee County; the scattered trees are tamarack.

Upland Grass

These upland sites contain less than 10% stocking of tree species or shrubs and are dominated by either grass, ferns or blueberries (Figure 68).

Upland grass areas display an extremely smooth texture with no detectable pattern or shape (Figure 69). The color of natural grass is light magenta to light blue or cyan in contrast to the brighter red magenta of managed grass (Figure 70).

Figure 68. Upland grass with less than 10% stocking of trees or shrubs.

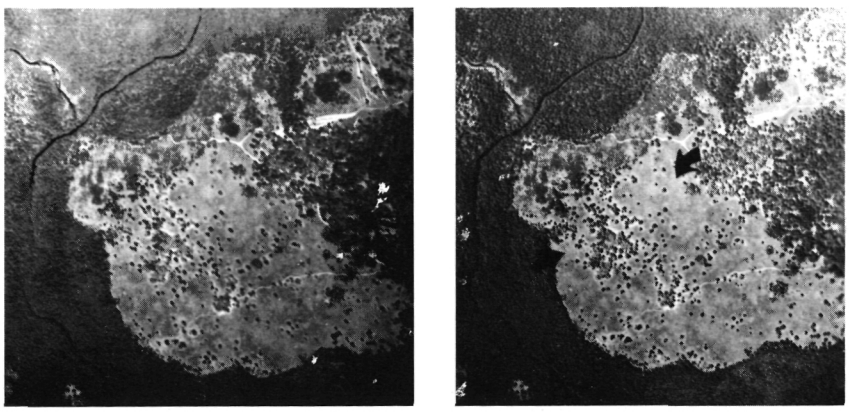

Figure 69. Upland grass, Montmorency County.

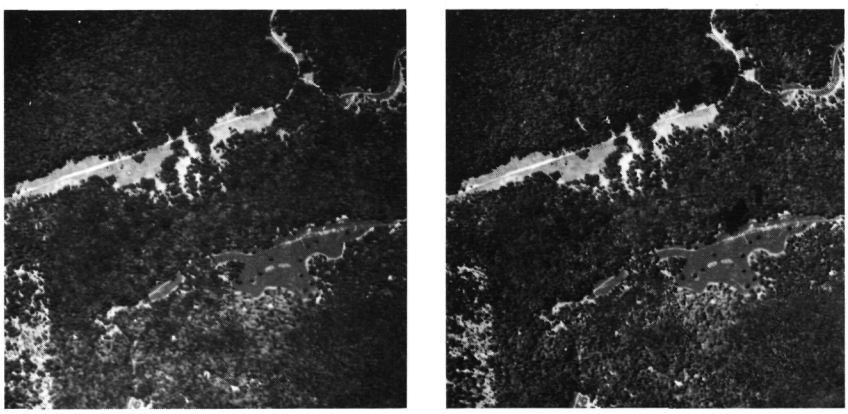

Figure 70. Comparison of natural grass (2) with an area of managed grass (1).

Upland Brush

These upland sites, mesic to dry, support at least 10% stocking of upland shrubs (briars, dogwood, sumac, etc.) (Figure 71). The upland brush type is moderately rough, may have slight shadow patterns and appears light pink to dark blue magenta (Figure 72).

Figure 71. Upland site with more than 10% stocking of upland shrubs (pin cherry and oak sprouts).

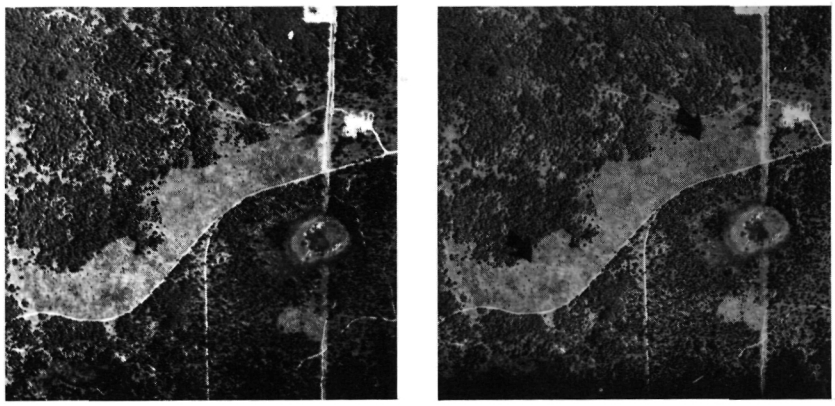

Figure 72. Upland brush, Kalkaska County.

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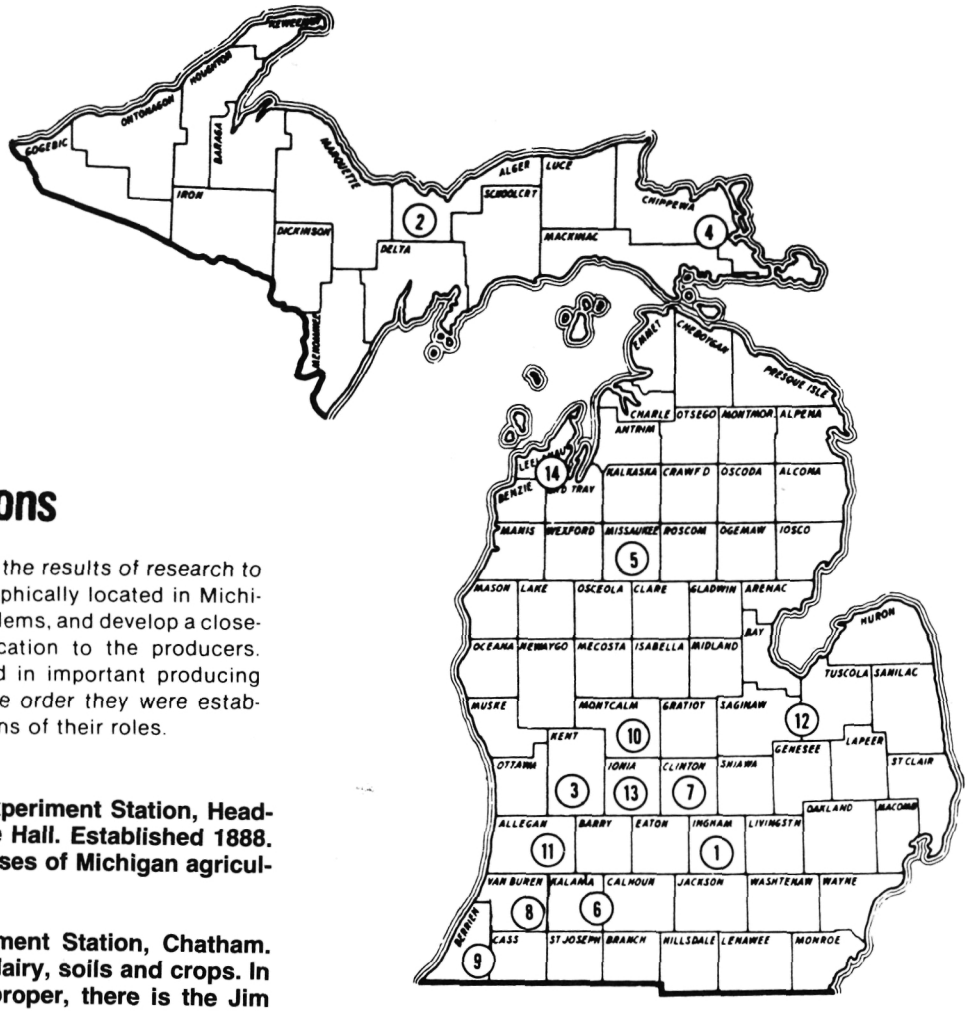
Appendix

Common and Scientific Names[1] of Tree Species

balsam fir	*Abies balsaemea*	pin cherry	*Prunus pensylvanica*
balsam poplar	*Populus balsamifera*	quaking aspen	*Populus tremuloides*
basswood	*Tilia americana*	red maple	*Acer rubrum*
beech	*Fagus grandifolia*	red oak	*Quercus rubra*
bigtooth aspen	*Populus gradidentata*	red pine	*Pinus resinosa*
black ash	*Fraxinus nigra*	shagbark hickory	*Carya ovata*
black cherry	*Prunus serotina*	sugar maple	*Acer saccharum*
black oak	*Quercus velutina*	tamarack	*Larix laricina*
black spruce	*Picea mariana*	white ash	*Fraxinus americana*
elm	*Ulmus sp.*	white birch	*Betula papyrifera*
hemlock	*Tsuga canadensis*	white oak	*Quercus alba*
jack pine	*Pinus banksiana*	white pine	*Pinus strobus*
northern pin oak	*Quercus ellipsoidalis*	white spruce	*Picea glauca*
northern white-cedar	*Thuja occidentalis*	yellow birch	*Betula alleghaniensis*

[1] *Scientific names are based on Little, 1979.*



Outlying Field Research Stations

These research units bring the results of research to the users. They are geographically located in Michigan to help solve local problems, and develop a closeness of science and education to the producers. These 14 units are located in important producing areas, and are listed in the order they were established with brief descriptions of their roles.

(1) Michigan Agricultural Experiment Station, Headquarters, 109 Agriculture Hall. Established 1888. Research work in all phases of Michigan agriculture and related fields.

(2) Upper Peninsula Experiment Station, Chatham. Established 1907. Beef, dairy, soils and crops. In addition to the station proper, there is the Jim Wells Forest.

(3) Graham Horticultural Experiment Station, Grand Rapids. Established 1919. Varieties, orchard soil management, spray methods.

(4) Dunbar Forest Experiment Station, Sault Ste. Marie. Established 1925. Forest, fisheries and wildlife management.

(5) Lake City Experiment Station, Lake City. Established 1928. Breeding, feeding and management of beef cattle and fish pond production studies.

(6) W. K. Kellogg Biological Station Complex, Hickory Corners. Established 1928. Natural and managed systems: agricultural production, forestry and wildlife resources. Research, academic and public service programs.

(7) Muck Soils Research Farm, Laingsburg. Plots established 1941. Crop production practices on organic soils.

(8) Fred Russ Forest Experiment Station, Decatur. Established 1942. Hardwood forest management.

(9) Sodus Horticultural Experiment Station, Sodus. Established 1954. Production of small fruit and vegetable crops. (land leased)

(10) Montcalm Experimental Farm, Entrican. Established 1966. Research on crops for processing with special emphasis on potatoes.

(11) Trevor Nichols Experimental Farm, Fennville. Established 1967. Studies related to fruit crop production with emphasis on pesticides research.

(12) Saginaw Valley Beet and Bean Research Farm, Saginaw. Established 1971, the farm is owned by the beet and bean industries and leased to MSU. Studies related to production of sugar beets and dry edible beans in rotation programs.

(13) Clarksville Horticultural Experiment Station, Clarksville. Purchased 1974. First plots established 1978. Research on all types of tree fruits, small fruits, vegetable crops and ornamental plants.

(14) Northwest Michigan Horticultural Experiment Station, Traverse City. Established 1979. Research and education for cherry and other horticultural crops in northwest Michigan.

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